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Geochemistry of Lower Crustal Granulite Xenoliths from Mindszentkalla and Sabarhegy, Pannonian Basin, Hungary

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Lower crustal granulite xenoliths have recently been found in Pliocene basaltic tuff at Mindszentkalla and Sabarhegy, western Pannonian Basin. Most of the xenoliths from these localities are similar to those of Bondorohegy and Szigliget previously described by Embey-Isztin et al. (1990) and Kempton et al. (1997) in that they are mafic meta-igneous rocks. However, garnet-rich varieties are frequent among Mindszentkalla and Sabarhegy granulite xenoliths indicating higher pressure of equilibration, whereas garnet is typically absent in Bondorohegy granulites and it is relatively rare at Szigliget. In general, the mineralogy is dominated by clinopyroxene, garnet (if present) and plagioclase. Accessory minerals comprise ilmenite, sphene, rutile, orthopyroxene and apatite. The texture is medium to coarse-grained, polygonal granoblastic indicating equilibrium conditions and annealing over a long period of time.

In addition to the meta-igneous granulites, for the first time a few metasedimentary granulites have also been found at Mindszentkalla and Sabarhegy. They have similar granoblastic textures as the mafic meta-igneous granulites, however their mineralogy is characterised by a high proportion of Al-rich phases, especially plagioclase and garnet and subordinate spinel. Clinopyroxene may be absent, or present in smaller amounts than in the mafic granulites. One sample contained a substantial amount of biotite. Graphite has also been found in three samples.

Mineral equilibrium may be assumed because of the lack of mineral zoning. The estimation of T and P has been performed by graphic means using several garnet-clinopyroxene thermometers at different pressures as well as barometers at different temperatures. The results indicate a considerable range of temperature and pressure mostly between 800 and 1000°C and 8-15 kbar. The temperature is considerably higher than in granulite xenoliths of Kola (Kempton et al., 1995) and this may result from the high temperature regime of the Pannonian Basin. However, peridotite xenoliths originating from the same or nearby vents define an even steeper geothermal gradient (Embey-Isztin & Dobosi submitted to Tectonophysics). Since the latter accords well with the present-day thermal conditions of the area, the P-T array defined by the lower crustal granulite xenoliths more probably represents a paleogeotherm. In any case, the discovery of garnet-rich lower crustal xenoliths was surprising since presently the basin is underlined by a thin (25-30 km thick) crust. In contrast, our pressure estimates indicate that the crust must have been considerably thicker (40-50 km) prior to the Tertiary collapse in the region.

Three metasedimentary xenoliths had the appropriate mineralogy for P-T determinations (T=854-920°C and 7.7 and 11.6kbar indicating that metasedimentary granulite xenoliths may have been exposed to the same P-T conditions as the meta-igneous granulites and therefore they may represent the fragments of an earlier lower crust that was underplated by mafic magmas now represented by the meta-igneous granulites.

The rocks all have low silica contents. The mafic meta-igneous samples have SiO_2 contents between 42 and 48wt%; more surprisingly, the samples identified as metasedimentary also have very low silica contents, as low as 37wt%, indicating that they are very refractory. The MgO contents of the meta-igneous xenoliths are generally 4-10wt%, and they have high Na/K ratios, mostly due to very low K_2O contents (generally 0.02 - 0.2). The metasedimentary samples show high Al_2O_3 contents (25wt%), indicating a metapelitic precursor.

Sr, Nd and Pb isotope data have been obtained for the new suite of lower crustal granulite xenoliths. The $^{143}Nd/^{144}Nd$ ratios range from 0.51307 to 0.51208. The lowest values are from the newly identified metasedimentary xenoliths and these samples greatly extend the array of Nd isotope values of the Hungarian lower crust previously presented by Kempton et al (1997). Present-day Sr isotope ratios of the mafic meta-igneous xenoliths are low (ca 0.7034) but the metasedimentary xenoliths have strongly radiogenic ratios (0.710). Thus, although many of the granulites plot in the depleted mantle field of the Sr-Nd isotope diagram, a significant number fall on an array that trends towards a more enriched component. These same samples also extend the Pb isotope array to more highly radiogenic values. Thus, the metasediments represent a previously unrecognised component in the lower crust of the Pannonian Basin.

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